

MECHANICAL CALCULATION COVER SHEET

Page i of iii

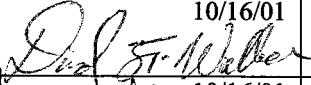
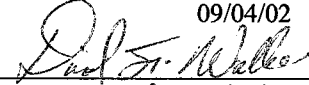
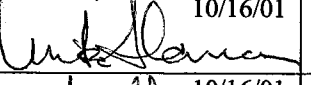
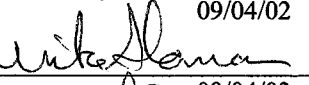
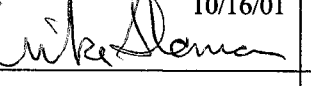
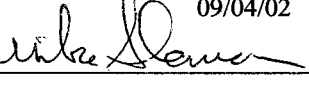
Calculation No:3442.053.MCAL.002,

Calculation Title: ENERGY AND MAINTENANCE COST ANALYSIS

Project ID # 100256

Project Title: CCN CHILLED WATER SYSTEM OPTIMIZATION MASTER PLAN

ORIGINAL AND REVISED CALCULATION/ANALYSIS APPROVAL

	Rev. A Name/Signature/Date	Rev. B Name/Signature/Date	Rev. 0 Name/Signature/Date
Originator: DAVID WALKER	10/16/01 		09/04/02 
Checked By: MIKE SLAMAN	10/16/01 		09/04/02 
Approved By: MIKE SLAMAN	10/16/01 		09/04/02 
Other:			

AFFECTED DOCUMENTS

Document Number	Document Title	Rev. Number
3442.053.ECAL.001	Short Circuit Analysis of SUS-H & MCC-1	0
3442.053.MCAL.001 through .006	CCF/LDCC COOLING PLANT MODIFICATIONS sheets G-0001, M0001 through M-8006, and E-0001 through E-7007	0
3442.053.MCAL.001 through .006.	LDCC EC-1 MODIFICATIONS sheets G-0001, M-0001 through M-8006, and E-0001 through E-7007.	0

Record of Revision

Rev.	Reason for Revision
REV A	FIRST SUBMITTAL OF CALCULATIONS
REV 0	ISSUED FOR CONSTRUCTION. NO TECHNICAL CHANGES FROM REV A. CHANGES TO THE AFFECTED DOCUMENTS ONLY, AS NOTED ABOVE.



CALCULATION CHECKLIST

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Task/Project #: 100256
Task Order 053
CCN CHILLED WATER
SYSTEM OPTIMIZATION
MASTER PLAN

Calculation Number: 3442.053.MCAL.002

Revision

AC 021

Reviewer/Checker : MIKE SLAMAN

Date
10/16/01

Reviewer performed or supervised subject calculation.

☒ NO ☐ YES Justification Attachment _____, _____ pages

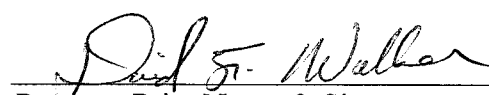
Alternate Verification method approved _____ Method _____

ITEM(S) CHECKED	Accept Y/N	OBJECTIVE EVIDENCE Sheets	INITIAL/ DATE 10/16/01
1. Cover forms properly completed.	Y		CS
2. Calculation Sheet headers complete with calc. no., rev., etc.	Y		CS
3. Calculation Sheet contents complete per format.	Y		CS
4. Listed attachments included.	N/A		
5. Calculation Objective clearly described.	Y		CS
6. Criteria are suitable and properly referenced to task-specific documents.	Y		CS
7. Assumptions and data described and attached or referenced to task documents.	Y ⁷		CS
8. Calculation method identified and appropriate for the design activity.	Y ⁸		CS
9. Calculation results reasonable and correctly described in Results and Conclusions.	Y ⁹		CS
10. Computer Program identified with version and revision.	N/A ¹⁰		
11. Computer Program references method used, etc.	N/A ¹¹		
12. Computer input/output provided.	N/A ¹²		
13. Computer run traceable to calculation.	N/A ¹³		
14. Computer input data within permissible design input range.	N/A ¹⁴		
15. Computer Program validation/verification addressed.	N/A ¹⁵		

REMARKS


Checker Print Name & Sign
MIKE SLAMAN

Date 10/16/01


Preparer Print Name & Sign
DAVID WALKER

Date 10/16/01



MECHANICAL
DESIGN CALCULATION SHEET

Project Title: CCN CHILLED WATER
SYSTEM OPTIMIZATION MASTER PLAN

Project ID #100256

Page iii of iii

Calculation No.

3442.053.MCAL.002

Rev. No.

NO DSW

**Calculation Title: ENERGY AND
MAINTENANCE COST ANALYSIS**

PERFORMED BY :

DAVID WALKER

10/16/01 DATE

CHECKED BY

MIKE SLAMAN

10/16/01 DATE

INTRODUCTION

Purpose The "Statement of Work" provided from LANL dated 7/24/01 states " Provide feasibility and Title II services to connect the CCF chilled water plant to the LDCC plant such that CCF chillers will be shut down and removed and the LDCC plant will be supplying chilled water to the CCF and outlying buildings." This work requires several objectives.

Scope 1. Provide economic justification for eliminating the CCF chiller plant and cooling tower 285.

DESIGN BASIS

- Design Inputs**
1. Test and Balance data performed by the Kirk Air Co. on 7/17/01 for CCF and Ambient Air Balance Co. for LDCC on 02/02/90.
 2. LDCC equipment room 189 cooling load calculations for LDCC Chiller Replacement Project I.D. 100015.
 3. Results from the pipe model program "Pipe Flo" created by Engineered Software INC. See Calculation M003.
 4. Field data- e.g. "equipment tag information and rated motor horse power, etc."

Criteria LANL electrical billing rates for large users.

- Assumptions**
1. The LDCC and CCF chiller plants operate 24 hrs/day/ 7days/week, and 52 weeks/year.
 2. The cooling load in both the LDCC and CCF building systems is more or less constant due to the cooling requirements of computers.
 3. Once the two chiller systems are combined into the LDCC chiller plant, The 900 ton more efficient chiller will be used as the primary chiller and will be loaded to 100% capacity.

REFERENCES

Test and Balance data and utility electrical rates

METHODS

Identify all pieces of equipment that utilize energy. Determine annual usage hours and power consumption. Multiply the annual Kilowatt-hr by the electrical usage rate to determine the annual cost of operation. Due this procedure for both CCF and LDCC chiller plants separate and combined.

**RESULTS AND
CONCLUSIONS**

There is significant energy and cost savings by eliminating the CCF chiller plant and cooling tower 285.

LDCC Chiller Plant Annual Energy Usage

700 ton Chiller

$$545 \text{ tons} \times \frac{.58 \text{ kW}}{\text{ton}} \times 8766 \text{ hrs/yr} \times \$0.0738/\text{kWh} = \$204,495.00$$

$$@ \underline{2,770,933 \text{ kWh/yr}}$$

Primary chilled water Pump

$$15 \text{ hp} \times \frac{.746 \text{ kW}}{\text{hp}} \times 8766 \text{ hrs/yr} \times \$0.0738/\text{kWh} = \$7,239.00$$

$$@ \underline{98,092 \text{ kWh/yr}}$$

Secondary chilled Water Pumps

$$40 \text{ hp} \times \frac{.746 \text{ kW}}{\text{hp}} \times 8766 \text{ hrs/yr} \times \$0.0738/\text{kWh} \times 2 = \$38,609.00$$

$$@ \underline{523,155 \text{ kWh/yr}}$$

Primary Cooling Tower Pump

$$125 \text{ hp} \times \frac{.746 \text{ kW}}{\text{hp}} \times 8766 \text{ hrs/yr} \times \$0.0738/\text{kWh} = \$60,326.00$$

$$@ \underline{817,430 \text{ kWh/yr}}$$

Secondary Cooling Tower Pump

$$40 \text{ hp} \times \frac{.746 \text{ kW}}{\text{hp}} \times 8766 \text{ hrs/yr} \times \$0.0738/\text{kWh} = \$19,304.00$$

$$@ \underline{261,577 \text{ kWh/yr}}$$

LDC Chiller Plant Annual Energy Use Cont.Cooling Tower Fans

VFD Controlled (Assumed Value)

$$40 \text{ hp} \times 70 \times 1 \text{ Fan} \times \frac{.746 \text{ kW}}{\text{hp}} \times 8766 \text{ hrs/yr} \times \$0.0738/\text{kWh} = \$13,513.00$$

$$@ 183,104 \text{ kWh/yr}$$

Cooling Tower Water Usage (Evap + Blowdown + Drift)

Compressor Heat

$$\text{Evap: } 1.25 \times 545 \text{ tons} \times \frac{13,000 \text{ Btu}}{\text{ton}} \times \frac{1 \text{ kW}}{1000 \text{ Btu}} \times 8766 \text{ hr/yr} \times \frac{1 \text{ gal}}{8.346 \text{ lbs}} \times \frac{1 \text{ hp}}{1000 \text{ gal}} = \$13,193.00$$

$$\text{Blowdown: } \frac{\text{Evap}}{\text{cycles} - 1} = \frac{8,586,375 \text{ gal}}{2.5 - 1} \times \$1.42 = \$8,128.00$$

$$\text{Drift: } .2\% \times \text{Flow} = .002 \times 6600 \frac{\text{gal}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times 8766 \text{ hr/yr} \times \$1.42 = \$9,859.00$$

Air Handling Unit EC-1

$$\text{Water: } 750 \frac{\text{lbs}}{\text{hr}} \times 3672 \frac{\text{hrs}}{\text{yr}} \times \frac{1 \text{ gallon}}{8.346 \text{ lbs}} \times \$1.42 = \$469.00$$

$$\text{Fans: } 14.5 \text{ bhp} \times 2 \text{ Fans} \times \frac{.746 \text{ kW}}{\text{hp}} \times 8766 \text{ hrs} \times \$0.0738/\text{kWh} = \$13,996.00$$

$$@ 189,645 \text{ kWh/yr}$$

Exhausts Fans EF-5, 6, & 7

$$5.6 \text{ Bhp} \times 2 \text{ Fans} \times \frac{.746 \text{ kW}}{\text{hp}} \times 8766 \text{ hrs} \times \$0.0738/\text{kWh} = \$5,405.00$$

$$@ 73242 \text{ kWh/yr}$$

$$\text{Total Annual LDC plant Energy Usage} = 14917178 \text{ kWh}$$

$$\text{Total Annual LDC plant Energy + Water Cost} = \$393,536.00$$

CCF Chiller Plant Annual Energy Usage

500 ton chillers

$$795 \text{ tons} \times \frac{0.58 \text{ kW}}{\text{ton}} \times \frac{8766 \text{ hrs}}{\text{YR}} \times \$0.0738 \frac{\text{kWh}}{\text{kWh}} = \$298,300.00$$

@ 4,042,003 kWh/YR

Primary chilled water pumps

$$40 \text{ hp} \times 2 \times \frac{.746 \text{ kW}}{\text{hp}} \times \frac{8766 \text{ hrs}}{\text{YR}} \times \$0.0738 \frac{\text{kWh}}{\text{kWh}} = \$38,609.00$$

@ 523,155 kWh/YR

Cooling Tower pumps

$$100 \text{ hp} \times 2 \text{ pumps} \times \frac{.746 \text{ kW}}{\text{hp}} \times \frac{8766 \text{ hrs}}{\text{YR}} \times \$0.0738 \frac{\text{kWh}}{\text{kWh}} = \$96,522.00$$

@ 1,307,887 kWh/YR

Cooling Tower Fan Motors

$$25 \text{ hp} \times 2 \text{ Fans} \times \frac{.746 \text{ kW}}{\text{hp}} \times \frac{8766 \text{ hrs}}{\text{YR}} \times \$0.0738 \frac{\text{kWh}}{\text{kWh}} = \$24,131.00$$

@ 326,972 kWh/YR

Cooling Tower Water Usage (EVAP + Blowdown + Drift)

EVAP: $1.25 \times 795 \text{ tons} \times \frac{8766 \text{ hrs}}{\text{YR}} \times \frac{12000 \text{ Btu/h}}{\text{ton}} \times \frac{1 \text{ lbw}}{1000 \text{ Btu}} \times \frac{1 \text{ gal}}{8.346 \text{ lbw}} \times \frac{\$1.42}{1000 \text{ gal}} = \$17,786.00$

Blowdown: $\frac{\text{EVAP}}{\text{cycles} - 1} = \frac{12,525,108 \text{ gal}}{2.5 - 1} \times \frac{\$1.42}{1000 \text{ gal}} = \$11,857.00$

Drift: $.2\% \times \text{Flow} = .002 \times 3000 \text{ gpm} \times \frac{60 \text{ min}}{\text{HR}} \times \frac{8766 \text{ HR}}{\text{YR}} \times \frac{\$6.42}{1000 \text{ gal}} = \$4,481.00$

CCF Chiller Plant Annual Energy Usage Cont.

Total Annual CCF Energy Usage = 6,200,017 KWH

Total Annual CCF Energy + Water Costs = \$491,686.00

Totals with chiller plants
Both in operation

Annual
Total Combined LDCC + CCF Energy Usage = 11,117,195 KWH

Annual
Total combined LDCC + CCF Energy + Water costs = \$885,222.00

LDCC Energy Usage With Added CCF
Cooling Load and Mechanical Room 189 Chilled
Water coil Load900 ton chiller - 90% Loaded

$$810 \text{ tons} \times 0.453 \frac{\text{kw}}{\text{ton}} \times 8766 \frac{\text{hrs}}{\text{yr}} \times \$0.0738 \frac{\text{Kwh}}{\text{Kwh}} = \$237,378.00$$

@ 3,216,508 Kwh/yr700 ton chiller - (90% Loaded of 660 tons - converted to R-123)

$$593 \text{ tons} \times 0.58 \frac{\text{kw}}{\text{ton}} \times 8766 \text{ hrs} \times \$0.0738 \frac{\text{Kwh}}{\text{Kwh}} = \$222,505.00$$

@ 3,014,978 Kwh/yrPrimary chiller water pumps

$$15 \text{ hp} \times 2 \text{ pumps} \times \frac{746 \text{ kw}}{\text{hp}} \times 8766 \frac{\text{hrs}}{\text{yr}} \times 0.0738 \frac{\text{Kwh}}{\text{Kwh}} = \$14,478.00$$

@ 196,183 Kwh/yrLDCC Secondary Pumps

$$40 \text{ hp} \times 2 \text{ pumps} \times \frac{746 \text{ kw}}{\text{hp}} \times 8766 \frac{\text{hrs}}{\text{yr}} \times 0.0738 \frac{\text{Kwh}}{\text{Kwh}} = \$38,609.00$$

@ 523,155 Kwh/yrCCF Secondary Pumps

$$40 \text{ hp} \times 2 \text{ pumps} \times \frac{746 \text{ kw}}{\text{hp}} \times 8766 \frac{\text{hrs}}{\text{yr}} \times 0.0738 \frac{\text{Kwh}}{\text{Kwh}} = \$38,609.00$$

@ 523,155 Kwh/yr

LDCC Energy Usage With Added CCF Cooling Load Cont.

Primary Cooling Tower Pump

$$125 \text{ hp} \times \frac{.746 \text{ kW}}{\text{hp}} \times \frac{8766 \text{ hrs}}{\text{yr}} \times \frac{\$0.0738}{\text{kWh}} = \$60,326.00$$

$$@ \frac{817,430 \text{ kWh}}{\text{yr}}$$

Secondary Cooling Tower pumps

$$40 \text{ hp} \times 2 \text{ pumps} \times \frac{.746 \text{ kW}}{\text{hp}} \times \frac{8766 \text{ hrs}}{\text{yr}} \times \frac{\$0.0738}{\text{kWh}} = \$38,609.00$$

$$@ \frac{523,155 \text{ kWh}}{\text{yr}}$$

Cooling Tower Fans

← VFD operated (Assumption)

$$40 \text{ hp} \times .70 \times 2 \text{ Fans} \times \frac{.746 \text{ kW}}{\text{hp}} \times \frac{8766 \text{ hrs}}{\text{yr}} \times \frac{\$0.0738}{\text{kWh}} = \$27,026.00$$

$$@ \frac{366,208 \text{ kWh}}{\text{yr}}$$

Cooling Tower usage (EVAP. + Blowdown + Drift)

← compressor heat

$$\text{EVAP: } 1.25 \times 1403 \text{ tons} \times \frac{8766 \text{ hrs}}{\text{yr}} \times \frac{12,000 \text{ Btu/h}}{\text{ton}} \times \frac{1 \text{ lbw}}{1000 \text{ Btu}} \times \frac{1 \text{ gal}}{8.346 \text{ lbw}} \times \$1.42 = \$31,388.00$$

$$\text{Blowdown: } \frac{\text{EVAP}}{2.5-1} = \frac{22,104,058 \text{ gal}}{2.5-1} \times \$1.42/1000 \text{ gal} = \$20,925.00$$

$$\text{Drift: } .2\% \times \text{Flow} = .002 \times 6600 \text{ gpm} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{8766 \text{ hrs}}{\text{yr}} \times \frac{\$1.42}{1000 \text{ gal}} = \$9,859.00$$

Air Handling Unit EC-1 Supply Fans

$$11.5 \text{ bhp} \times 3 \text{ Fans} \times \frac{.746 \text{ kW}}{\text{hp}} \times \frac{8766 \text{ hrs}}{\text{yr}} \times \frac{\$0.0738}{\text{kWh}} = \$16,650.00$$

$$@ \frac{225,611 \text{ kWh}}{\text{yr}}$$

LDCC Energy Usage With Added CCF cooling Load Cont.

Exhaust Fans EF-5, 6, & 7

$$7.6 \text{ bhp} \times 2 \text{ Fans} \times .746 \text{ kW/hp} \times 8760 \frac{\text{hrs}}{\text{yr}} \times \frac{90.0785}{\text{kWh}} = \$7,326.00$$

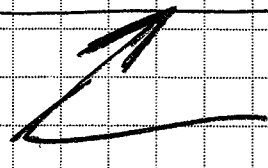
@ 99,399 kWh

Total Annual LDCC w/CCF Added ^{cooling} Loads Energy usage = 9,505,782 kWh

Total Annual LDCC w/CCF Added cooling Loads Energy + water costs = \$763,698.00

Annual Energy + Cost Savings By Eliminating The CCF Chiller Plant and CT-205.

$$\begin{aligned} \text{Energy: } & 11,117,195 \text{ kWh} - 9,505,782 \text{ kWh} = 1,611,413 \text{ kWh} \\ \text{Costs: } & \$885,222.00 - \$763,698.00 = \$121,524.00 \end{aligned}$$

 **Overall Savings**

3442.053.MCAL.002,Rev A
CONDENSED WATER Calc

Dgw

Received: from gateway.bpce.com
(bpce.com [207.108.252.130])
by BP3; Thu, 08 Feb 2001 15:08:31 -0700
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by gateway.bpce.com (8.11.1/8.11.1) with ESMTP id f18M8SC25261
for <MAS@bpce.com>; Thu, 8 Feb 2001 15:08:28 -0700
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Date: Thu, 08 Feb 2001 15:07:06 -0700
To: "Michael Slaman" <MAS@bpce.com>
From: "Emilio A. Racine, PE" <eracine@lanl.gov>
Subject: Re: LANL - User utility rates
In-Reply-To: <sa800cda.057@BP3>
Mime-Version: 1.0
Content-Type: text/plain; charset="us-ascii"; format=flowed

Mike,

TA-18 Utility billings are based on per square ft.
There are no electric or gas meters at TA-18 that are used
for collecting energy usages. A one time electric energy usage
profile was made and this is the basis for the billings.

Gas for heating Lab-wide is per sq ft also. the Laboratory pays
~~\$8.40~~/Dtherm. The following are the rates for TA-18:

Heat (gas) \$0.29664167/sq ft/month = fixed \$ 14,159.30/month
Electric fixed \$44,966.51/month

The following are the Laboratory rates:

Heat(gas, steam) ~~\$3.55~~ ^{\$3.93} 97/sq ft/year
Water & Wastewater \$2.0027/sq ft/year

Electric Rate:

Small & profiled users \$0.0872/KWH
Large users with demand charge \$0.0738/KWH This would apply to TA-55

I hope this helps.

Emilio

Pat Archer 665-5082
Bill Baker 667-7756
WM

At 02:39 PM 2/6/01 -0700, Michael Slaman wrote:

8/27/01
Gas & Steam
\$3.93 / ft² / year

Demand charge
NOT

Current 8/27/01